Tax Progressivity in Australia:

A Dynamic General Equilibrium Analysis

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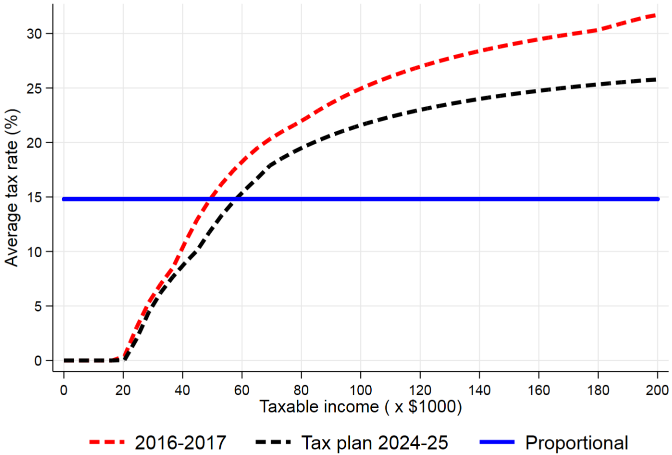
27th Colloquium on Pensions and Retirement Research
3 December 2019

Contents

Outline

Motivation



Approximation based on standard schedule and LITO

Arguments for and against progressivity

For: Relieve poorer individuals from higher tax burden...

- during a **negative shock** (social insurance role)
- for those with **unfavorable initial conditions** (redistributive role)

Against: Adverse incentive effects

- Discourage from saving and working
  - Higher effective marginal tax rate for each additional dollar earned

But income tax is only one part of the broader tax-transfer system.

This paper

- Examine tax progressivity **conditional on**
  - various specifications of **age-pension system**
  - public transfers (below 65 years)
- Tool:
  - Dynamic general equilibrium OLG calibrated to the Australian economy
  - Heterogenous households (3 skill types, idiosynctractic labor income risk)
- Approach:
  - Compare between alternative steady state economies with different income tax progressivity

Results: main points

- Less progressivity improves aggregrate efficiency and welfare
- Optimal income tax is proportional (highest gains for **all households**)
- Interaction between tax progressivity and pension system design
  - Changing pension design does not affect optimal tax progressivity
  - Trade-offs between reducing taper rates and increasing income tax rates
  - Efficiency gains from less progressivity $\Longrightarrow$ Less reliance on age pension in retirement

Important to account for existence and design of public transfer programs when considering tax progressivity.

Key factors driving the results

Increased incentives outweigh social insurance effects

- Lower progressivity has large positive effect on savings
  - Robust at different levels of risk aversion and capital mobility assumptions (magnitude varies)
- Labor supply
  - Intensive margin: large increase in hours
  - Extensive margin: small decrease in participation rates
  - (Robust with constant vs. changing Frisch elasticity)

CONDITIONAL on the existence of public transfer system

Related literature

1. **Optimal income tax progressivity:**
   - Conesa and Krueger (2006);Heathcote, Storesletten and Violante (2017)
2. **Optimal pension systems:**
   - Imrohoroglu, Imrohoroglu and Jones (1995); Sefton and van de Ven (2008); Kudrna and Woodland (2011);Tran and Woodland (2014)
3. ***Optimal progressivity and optimal social security:***
   - Krueger and Ludwig (2016); Jung and Tran (2017)...McKay and Reis (2016);
4. Fiscal policy analysis in Australia using OLG models

Outline

Key features

- Dynamic general equilibrium OLG
- Stationary demographics (constant population growth, age dependent survival probability)
- Sectors:
    - Households (heterogenous)
        - 3 types: low skilled, medium skilled, high skilled
        - Differs by labor productivity (deterministic and stochastic shocks over lifecycle)
    - Government (balanced budget)
    - Firm (representative)
    - Foreign (small open economy)

Household heterogeneity

- 3 skill types

$$\rho \in \{low, medium, high\}$$

- Deterministic labor efficiency

$$e_{\rho,j}: \text{ differs by skill type \& evolves over age } j$$

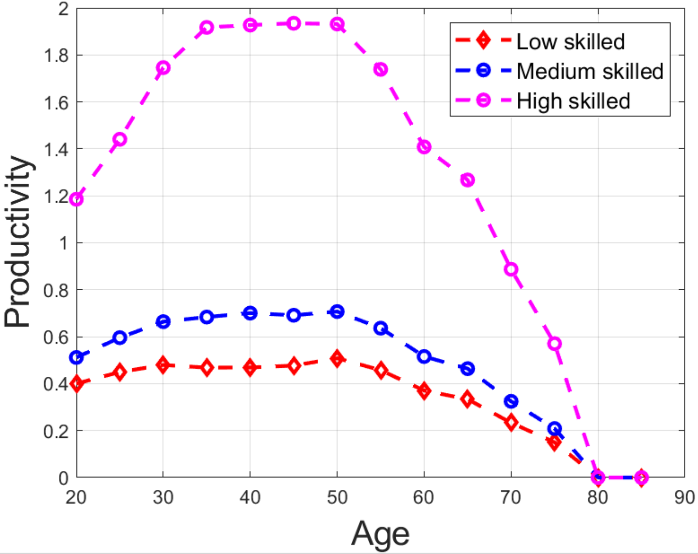
- Stochastic shocks

$$z_{\rho,j} = [low, medium, high]$$

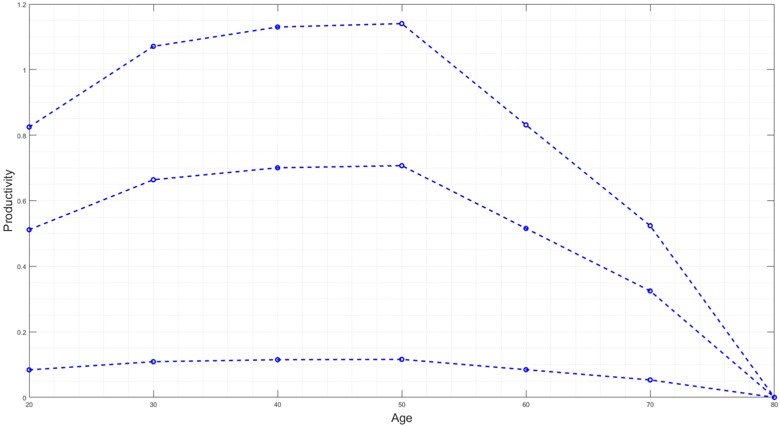
- Markov transition matrix

$$\pi_j \left(z_{\rho,j+1} | z_{\rho,j} \right) \quad (1)$$

Deterministic labor productivity by skill type



Stochastic shock (Example: medium skilled worker)



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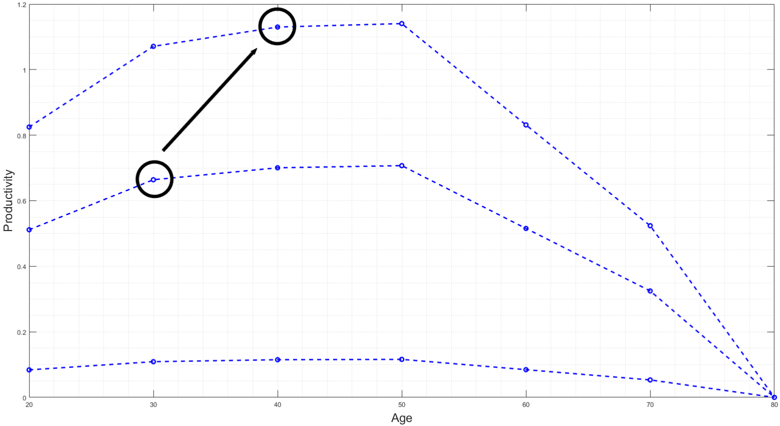

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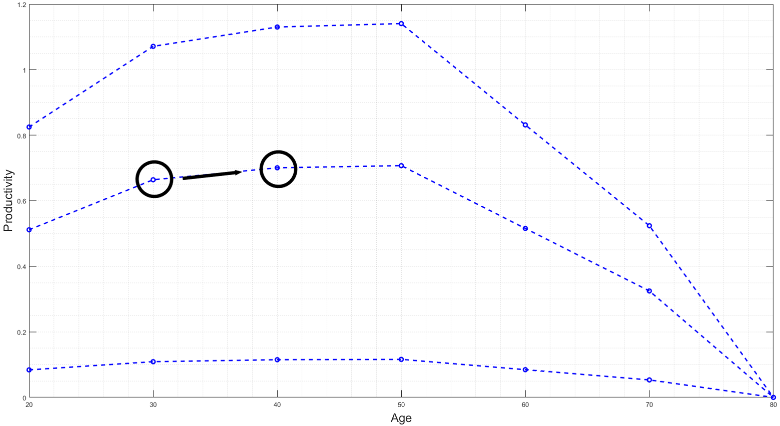

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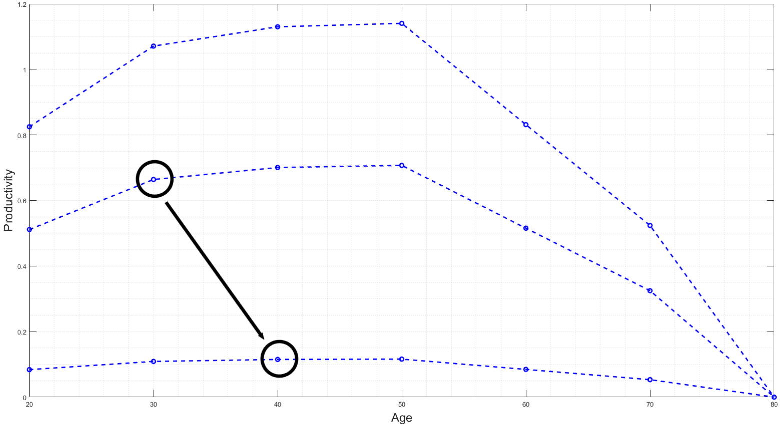

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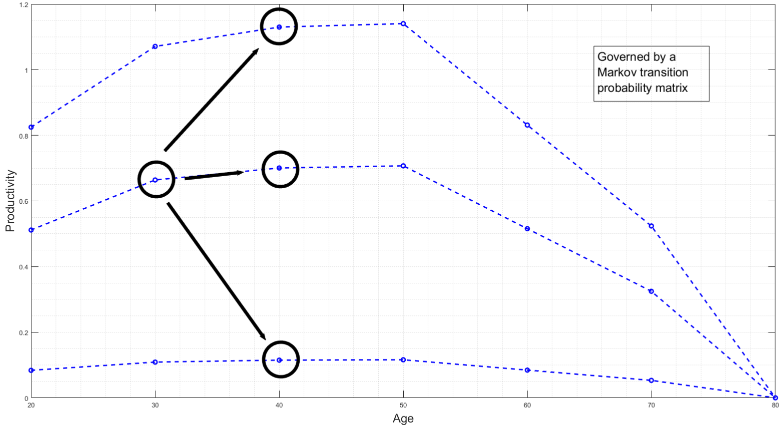


Household decision problem (summary)

- Optimal decisions over consumption c and leisure l

$$u(c_j, l_j) = \frac{\left[c_j^{\gamma} l_j^{1-\gamma}\right]^{1-\sigma}}{1-\sigma}$$

- Maximize expected lifetime utility subject to

$$a_{j+1} + (1+\tau^c)\, c_j = \overbrace{a_j(1+r) + e_j z_j (1-l_j)\, w}^{\boldsymbol{y_j}} + b_j$$

$$+ st\left(z_{\rho,j}\right) \quad \text{Public transfer} < 65 \text{ years}$$

$$+\boldsymbol{P}\left(\boldsymbol{a_j}, \boldsymbol{y_j}\right) \quad \text{Means tested pension} >= 65 \text{ years}$$

$$-\boldsymbol{T}\left(\boldsymbol{y_j}\right) \quad \text{Income tax}$$

Parametric tax function

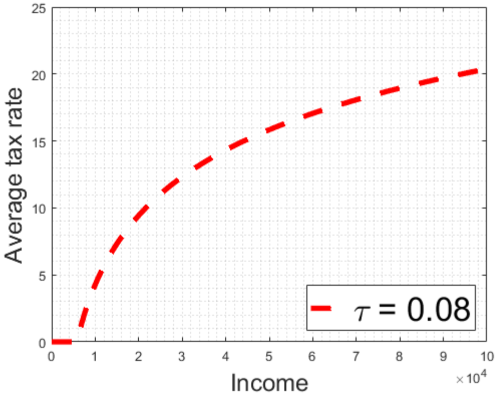
$$\underbrace{T(y) = y - \lambda y^{1-\tau}}_{\text{Tax liability}} \qquad \underbrace{t(y) = 1 - \lambda y^{-\tau}}_{\text{Average tax rate}}$$

- τ **progressivity (slope)** λ scale
- $\tau = 0$ proportional, $\tau > 0$ is progressive, $\uparrow \tau \Longrightarrow \uparrow$ **progressivity**.

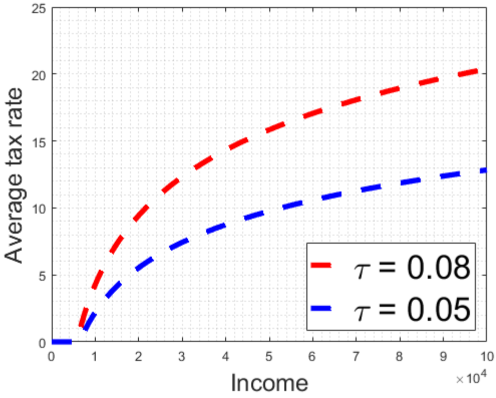
Table: ATO select years

	2008	2012	2016
τ	0.086	0.082	0.081
	(0.001)	(0.001)	(0.001)
λ	2.129	2.073	2.048
	(0.007)	(0.005)	(0.006)
Adjusted R^2	0.99	0.99	0.99

Parametric tax function



Parametric tax function



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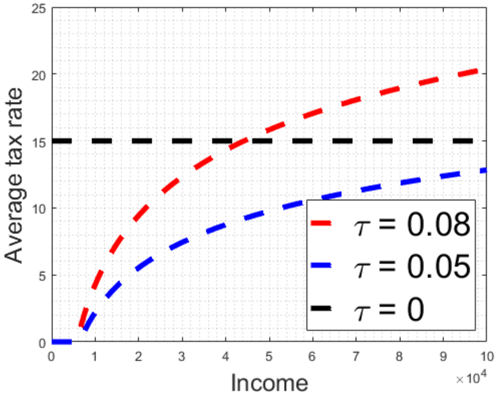


Age-pension

- Eligible $j \geq 65$
- Pension

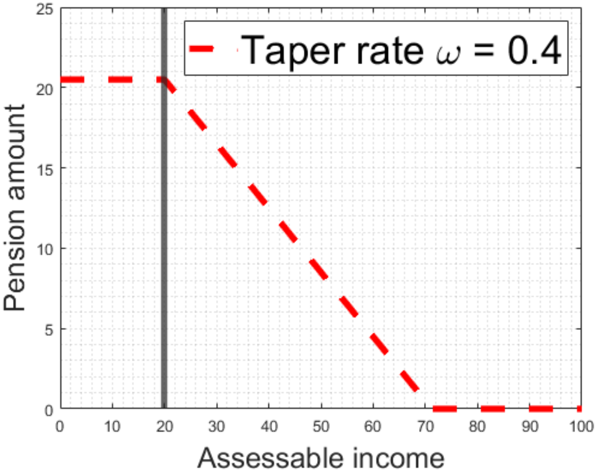
$$P(a_j, y_j) = \min\left[P_j^y, P_j^a\right] \tag{2}$$

- P_j^a: pension from asset test. P_j^y: pension from income test (this talk)

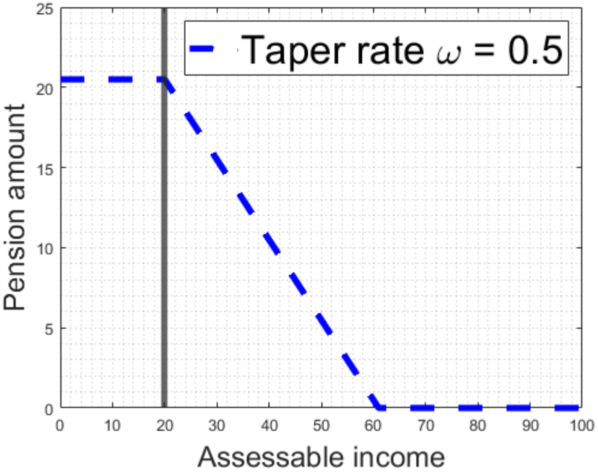
$$\mathscr{P}^y(y) = \begin{cases} p^{\max} & \text{if } y_j \leq \bar{y}_1 \\ p^{\max} - \omega^y(y_j - \bar{y}_1) & \text{if } \bar{y}_1 < y_j < \bar{y}_2 \\ 0 & \text{if } y_j \geq \bar{y}_2 \end{cases} \tag{3}$$

- $p^{\max}$: maximum benefit. ω^y: taper rate. $\bar{y}_1$: low income threshold. $\bar{y}_2 = \bar{y}_1 + p^{\max}/\omega^y$

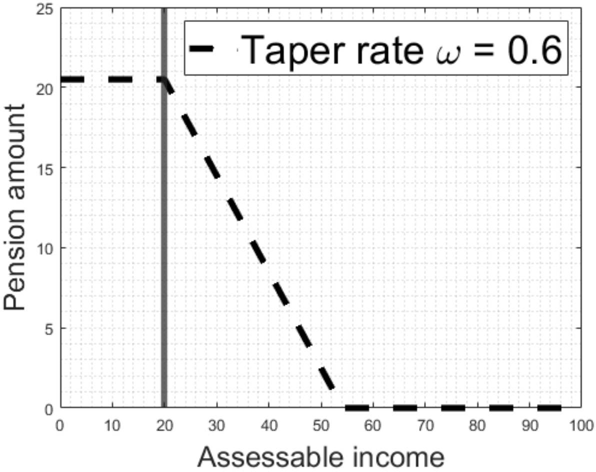
Income test


Taper rate ω = 0.4
Pension amount
Assessable income
0
5
10
15
20
25
0
10
20
30
40
50
60
70
80
90
100

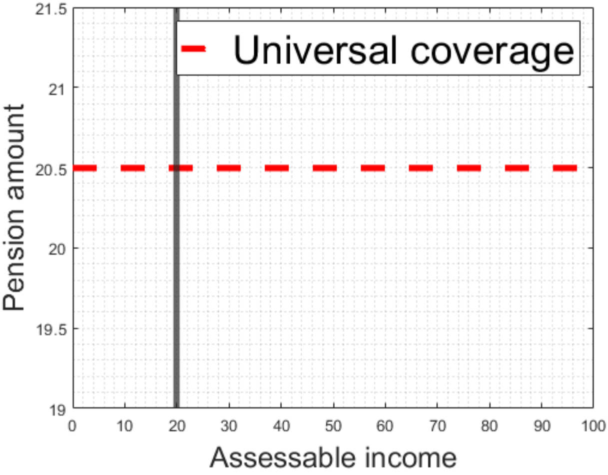
Income test


Taper rate ω = 0.5
Pension amount
Assessable income
0
5
10
15
20
25
0
10
20
30
40
50
60
70
80
90
100

Income test


Taper rate ω = 0.6
Pension amount
Assessable income
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100

Income test


Universal coverage
Pension amount
21.5
21
20.5
20
19.5
19
0
10
20
30
40
50
60
70
80
90
100
Assessable income

Government budget

$$\underbrace{\text{Income tax}}_{\sum(\boldsymbol{y}-\lambda \boldsymbol{y}^{1-\tau})} + \text{Consumption tax} = \text{Pension} \ + \overbrace{\text{Public transfers} + G + rD}^{\text{exogenous expenses}}$$

- Government adjusts scale of income tax to balance the budget

$$\lambda = \frac{\sum \boldsymbol{y} + \text{Consumption tax} - \text{Expenses}}{\sum \boldsymbol{y}^{(1-\tau)}} \tag{4}$$

Outline

Four policy experiments

Vary tax progressivity τ^y with

1. **Pension system fixed (this talk)**
2. Varying means-test taper ω^y
3. Varying maximum benefit $p^{\max}$
4. Varying ω^y at different levels of maximum benefit $p^{\max}$

Social welfare criterion

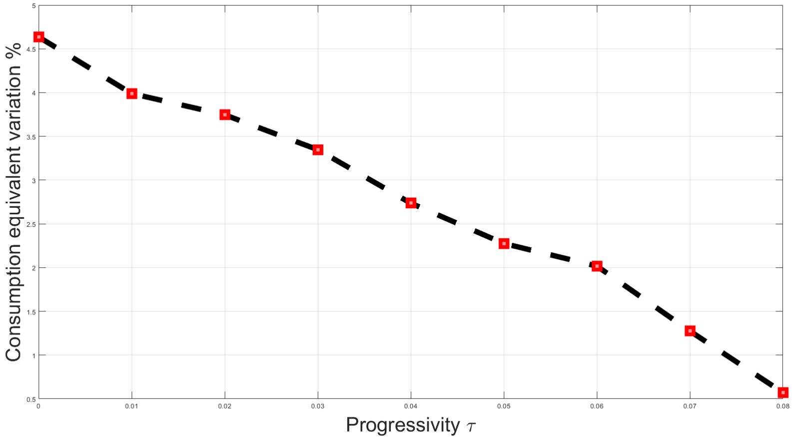
Welfare: ex-ante expected lifetime utility of an individual born into the stationary equilibrium given policy parameters

- Total by skill type
- Utilitarian social welfare (sum of expected utilities of all newborn agents)

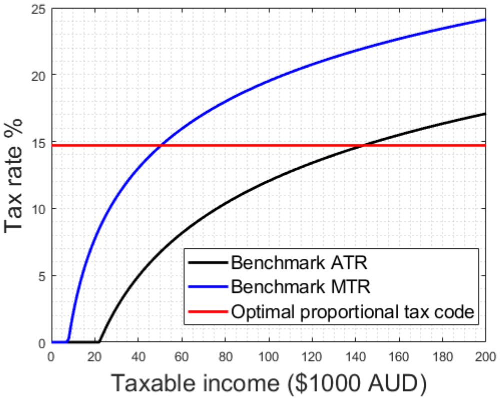
Compare steady states in terms of

CEV: percentage increase in consumption needed to make a household indifferent between being born in the benchmark and being born into alternative

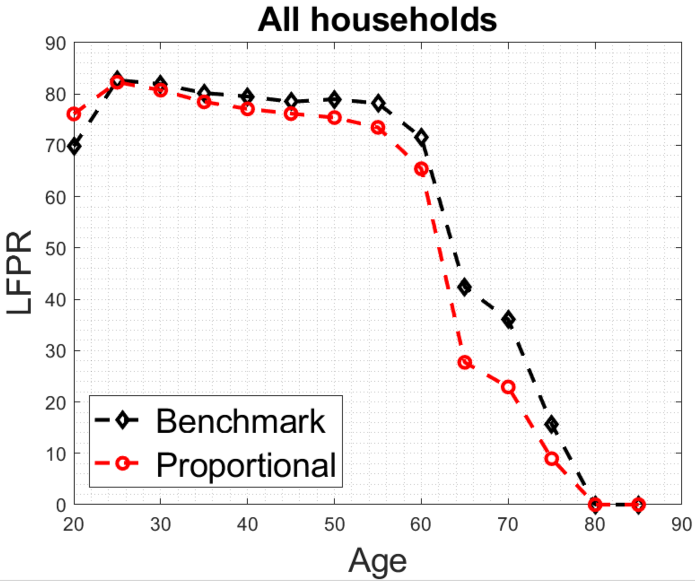
Experiment 1: welfare at different τ^y



Optimal tax code



Labor force participation rate



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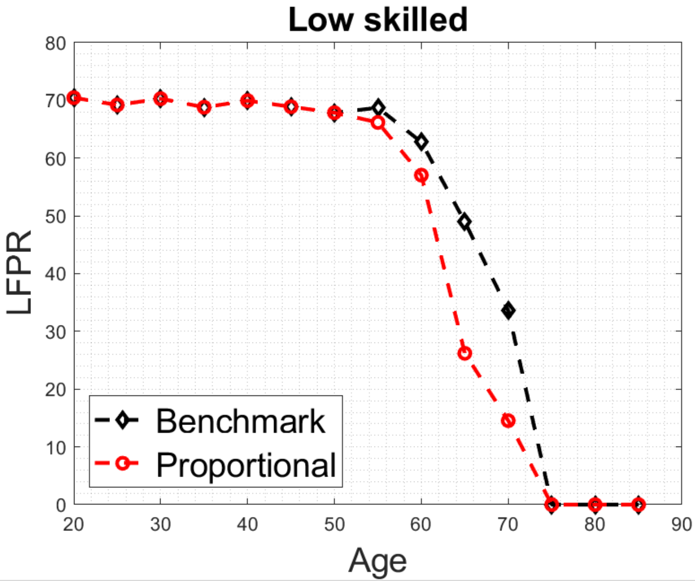
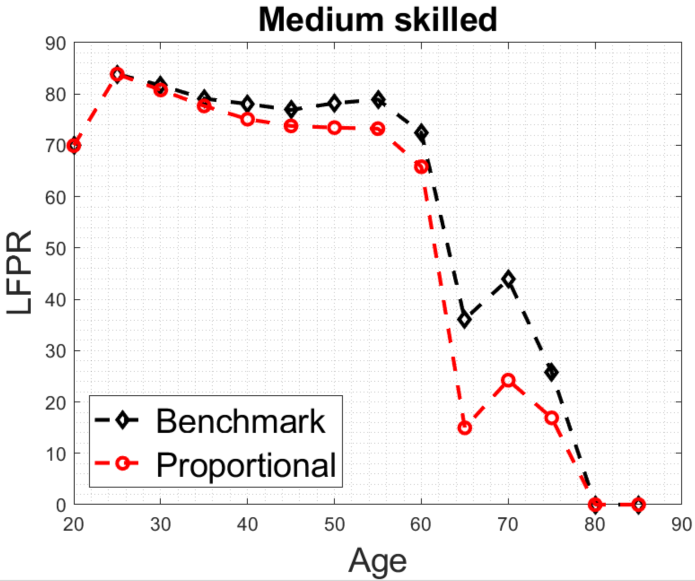
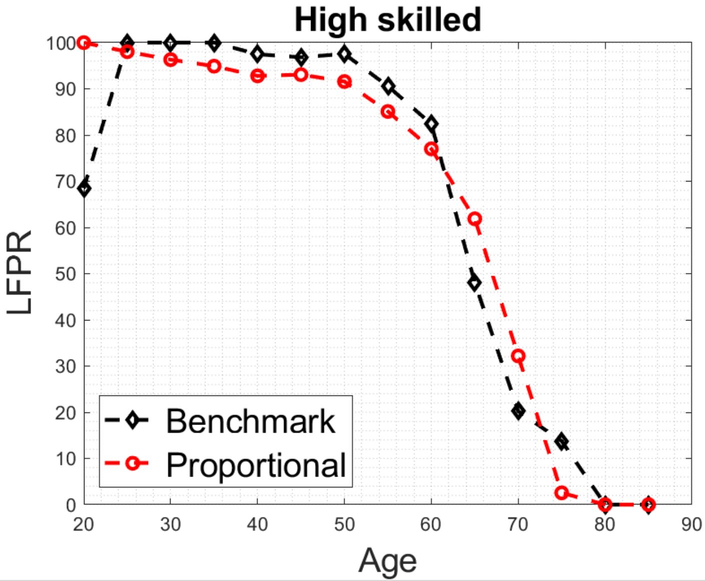


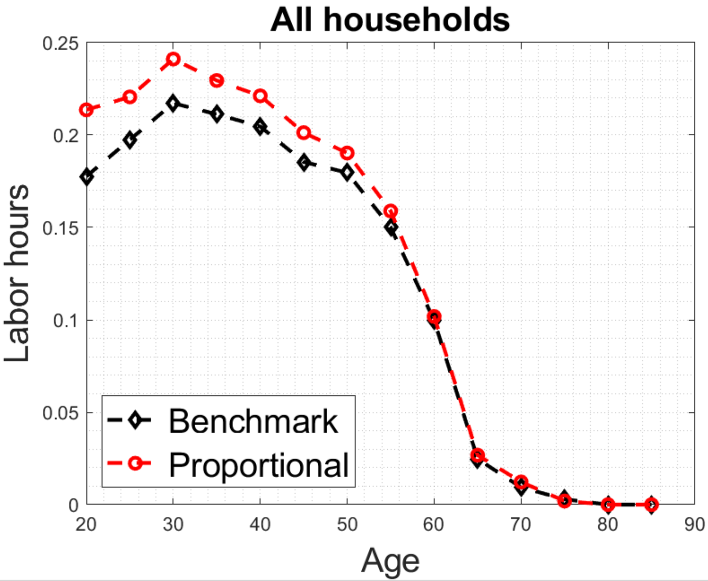
Labor force participation rate



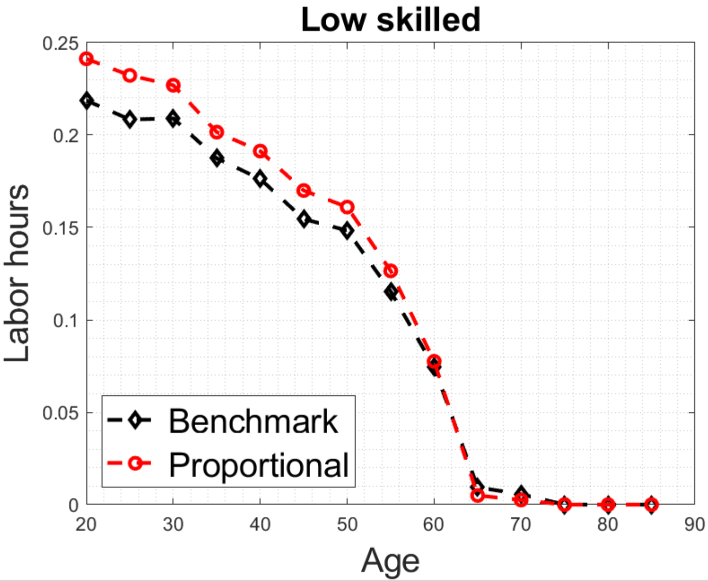
Labor force participation rate



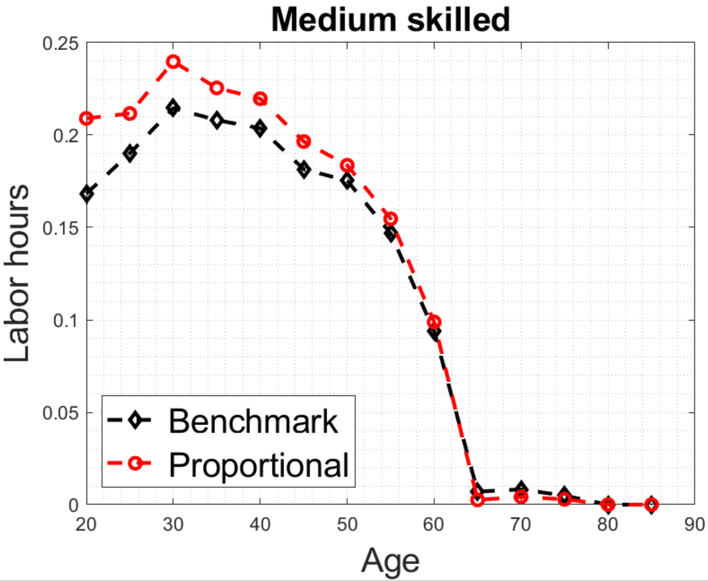
Labor hours


All households
Labor hours
Age
0.25
0.2
0.15
0.1
0.05
0
20
30
40
50
60
70
80
90
Benchmark
Proportional

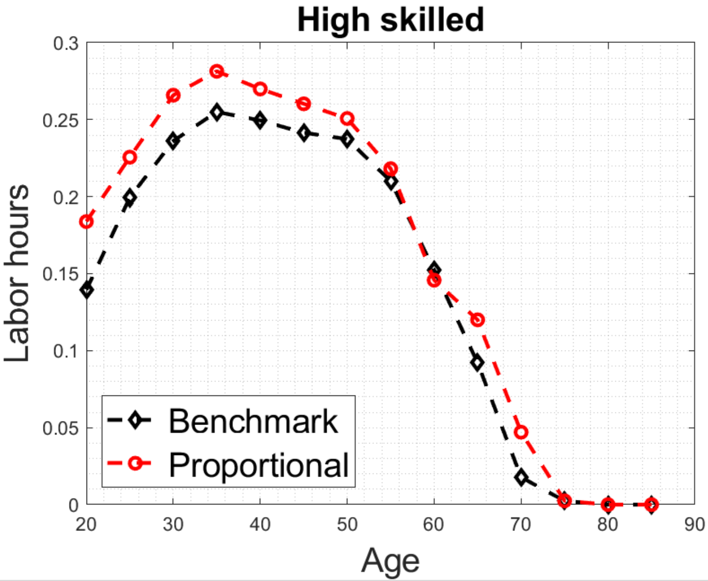
Labor hours


Low skilled
Labor hours
0.25
0.2
0.15
0.1
0.05
0
20
30
40
50
60
70
80
90
Age
Benchmark
Proportional

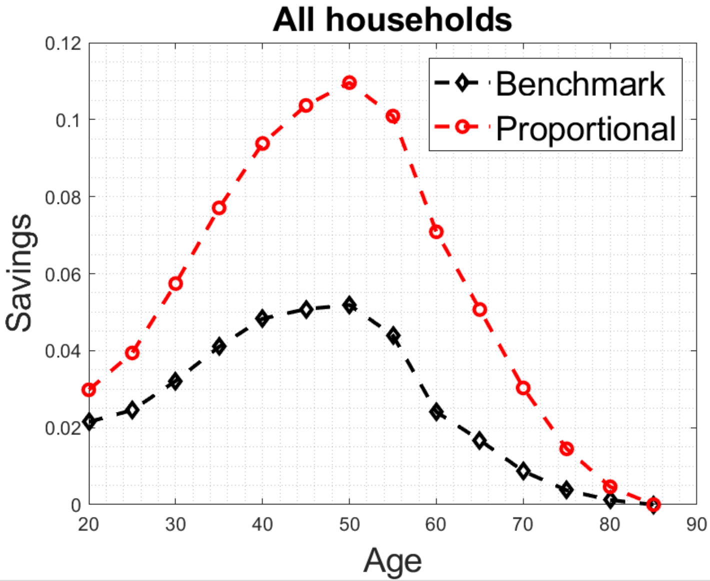
Labor hours


Medium skilled
0.25
0.2
0.15
0.1
0.05
0
Labor hours
20
30
40
50
60
70
80
90
Age
Benchmark
Proportional

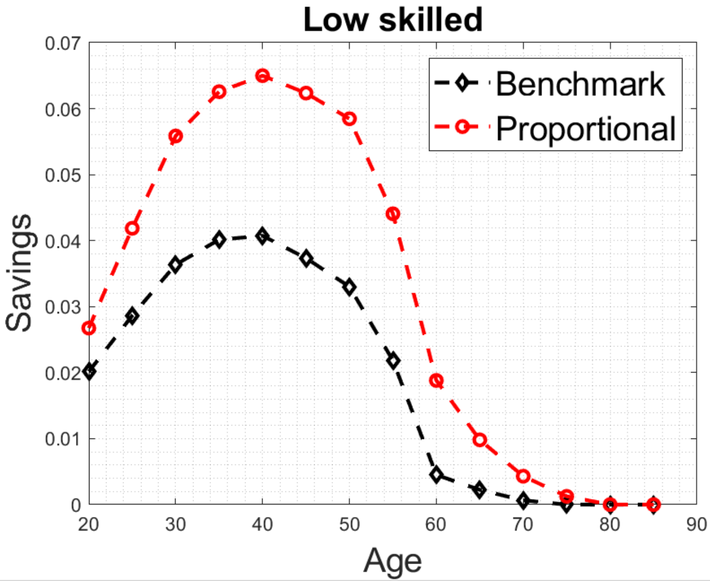
Labor hours


High skilled
Labor hours
0.3
0.25
0.2
0.15
0.1
0.05
0
20
30
40
50
60
70
80
90
Age
Benchmark
Proportional

Savings over age



Savings over age



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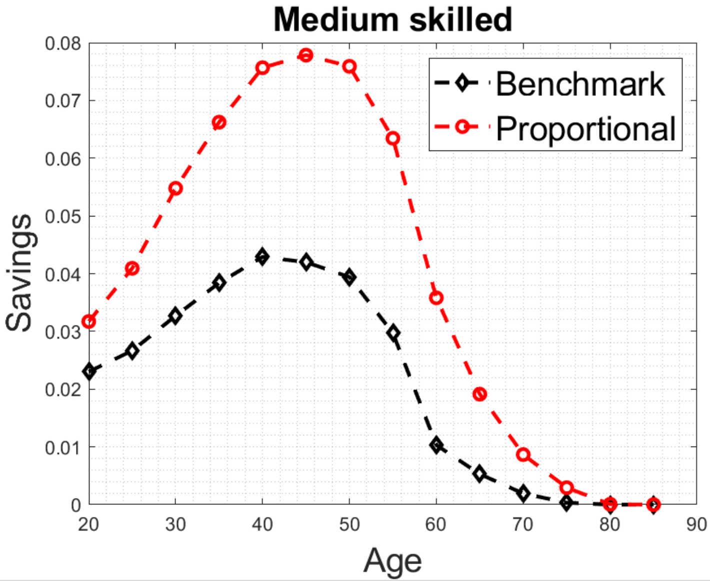

Savings over age

Aggregate effects: optimal with benchmark pension

Table: Percentage change in aggregates relative to benchmark

		By skill type		
	Aggregate	**Low**	**Medium**	**High**
Percent of households in skill type		30	50	20
Welfare (*CEV*)	4.64	**4.19**	**4.36**	**6.27**
GDP	40			
Savings	94	60	76	150
Labor supply (hours worked)	11	9	12	13
Labor force participation rate	-2	-3	-5	4
Wage rate	24			
Average tax rate (averaged by group)	**-9**	**5**	**-2**	**-35**
Percent of pensioners	-5	0.00	0.00	-25
Total pension	-9	-1	-3	-42

Aggregate effects: optimal with benchmark pension

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Income inequality

Table: Gini coefficients: benchmark,and optimal tax code

	Benchmark	Optimal	Change
Labor income	0.60	0.58	-0.02
Capital income	0.52	0.54	+0.02
Net income	0.39	0.44	+0.05
Consumption	0.30	0.37	+0.07
Wealth	0.56	0.63	+0.07

Decomposition: effect of change in progressivity

- Counterfactual: partial equilibrium with optimal income tax code and benchmark wage (Column 2)

Table: Welfare and aggregate output effects - optimal versus counterfactual

	(1) Optimal (Overall effect)	**(2) Fixed** w, λ (Tax effect)
Wage rate	0.40	0.32
Average tax rate (%)	14.71	14.71
Welfare (CEV)	4.64	1.46
- Low skilled	4.19	1.09
- Medium skilled	4.36	1.25
- High skilled	6.27	2.78
GDP (%△ rel. bench)	39.97	22.49

Sensitivity checks: alternative preferences

$$u(c,l) = \frac{\left[c^{\gamma} l^{1-\gamma}\right]^{1-\sigma}}{1-\sigma} \text{ or } u(c,l) = \frac{c^{1-\sigma}}{1-\sigma} - \chi \frac{(1-l)^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}$$

Table: Optimal progressivity and taper rate under alternative preferences

Labor supply elasticity	Optimal τ^y	Average tax rate (%)
Varying over the lifecyle with $\sigma = 2$ (benchmark)	0	9
Varying over the lifecyle with $\sigma = 3$	0	15
Varying over the lifecyle with $\sigma = 4$	0	15
Constant Frisch elasticity	0	16
Imperfect capital mobility	0	15

σ is risk aversion parameter; Frisch is $\frac{l}{1-l}\frac{1-\gamma(1-\sigma)}{\sigma}$

Sensitivity and extensions

- **Results are not robust to**
  - Strict restrictions on hours worked (choice to not work, work part time or work full time)
    - welfare gains from decreasing progressivity up to a certain point
    - optimal tax code not proportional, less progressive than benchmark
- **Extensions:**
  - model public transfers in greater detail
  - frictions in the labor market
  - richer assets (superannuation, housing)
  - transition path

Outline

General message

- Case for reducing income tax progressivity
  - increased incentives to work and save
  - leads to less reliance on age-pension in retirement
- Case for reducing pension taper rates
  - reduce distortions
  - comes at the cost of higher average tax rates
- Optimal design of public transfers matter in the tax progressivity debate
  - ensure equity and social insurance
  - further research crucial

Thank you

Thank you

Appreciate your feedback and questions

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More fun slides follow...

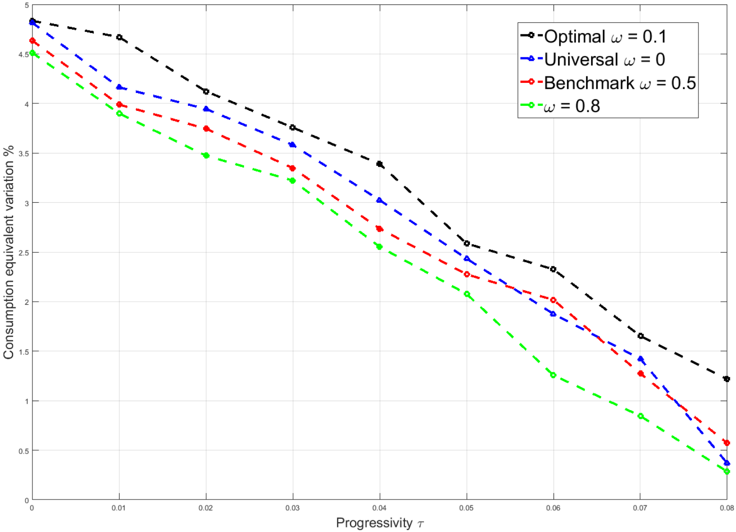
Outline

Four policy experiments

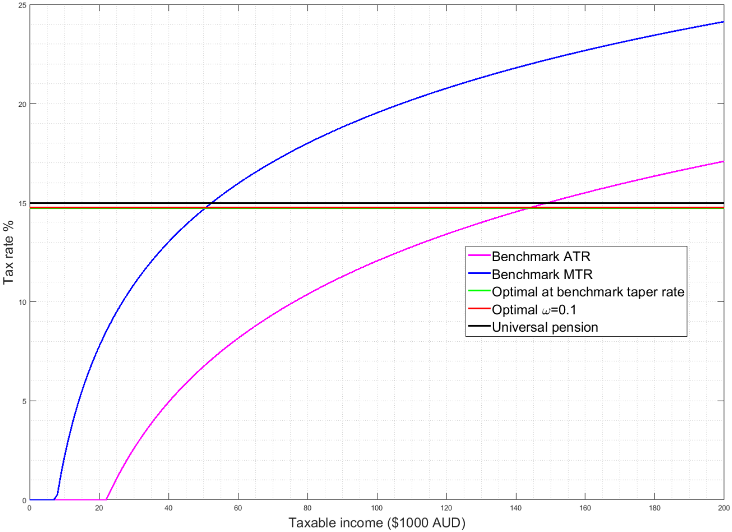
Vary tax progressivity τ^y with

1. Pension system fixed
2. **Varying means-test taper ω^y**
3. **Varying maximum benefit p^{max}**
4. **Varying ω^y at different levels of maximum benefit p^{max}**

Experiment 2: welfare at different τ^y at different taper rates



Optimal tax code



Experiment 2: Varying taper rate

Table: Proportional income tax with alternative pension taper rates

Taper rate ω^y	0	0.1	0.5 (bench)
Average tax rate (%)	14.97	14.75	14.71
Welfare (*CEV*)	**4.82**	**4.83**	4.64
GDP	41.54	41.53	39.97
Savings	97.49	98.19	94.35
Labor supply (hours worked)	12.70	12.14	11.12
Labor force participation rate	-0.45	-0.80	-2.18
Average tax rate (mean)	-7.23	-8.67	-9.37
Total pension	5.74	-0.50	-8.64

Experiment 3: Varying maximum benefit

Table: Optimal tax code and aggregate effects with different maximum pension benefits

	$p^{max}(\varphi) = \varphi p^{max,benchmark}$				
φ	0.00	0.50	1.00	1.50	2
Optimal τ^y	0	0	0	0	0
Average tax rate (%)	5.90	8.54	14.71	24.57	33.55
Welfare (CEV%)	8.33	6.87	4.64	1.05	1.94
GDP	101.77	74.28	39.97	8.22	-7.51
Savings	318.39	207.38	94.35	12.40	-20.73
Labor	26.80	19.98	11.12	5.02	3.05

Experiment 4: Varying maximum benefit and taper rate

Table: Welfare effects of adjusting taper rates under a proportional tax in economies different levels of pension beneft

	CEV% (relative to benchmark)		
Taper rate	$\varphi = 0.5$	$\varphi = 1$	$\varphi = 1.5$
0	6.89	4.82	**2.04**
0.1	**6.97**	**4.83**	**2.04**
0.2	6.96	4.81	2.03
0.3	6.94	4.75	1.99
0.4	6.91	4.70	1.29
0.5	6.87	4.64	1.05
0.6	6.84	4.55	0.96
0.7	6.85	4.56	0.68
0.8	6.88	4.51	0.57
0.9	6.90	4.48	0.46
1	6.90	4.47	0.22

Outline

Model

Demographics

- Age $j \in [1, ..., J]$. In each period, a continuum of agents aged 1 are born and live upto a maximum of J periods.
- Constant population growth at rate n.
- Agents face survival probability ψ_j of surviving up to age j conditional on being alive at age $j-1$.
- Fraction of population of age j at any point in time

$$\mu_j = \frac{\mu_{j-1}\psi_j}{(1+n)} \tag{5}$$

Model

Prefrences

$$U_0 = E\left\{\sum_{j=1}^{J}\left[\beta^{j-1}\psi_j u\left(c_j, l_j\right) + \left(1-\psi_j\right)\phi\left(b_{j+1}\right)\right]\right\} \quad (6)$$

- Identical lifetime preferences over consumption $c_j \geq 0$ and leisure $l_j \in (0, 1]$.
- Bequests are given by $b\left(a_{j+1}\right) = a_{j+1}$ following De Nardi (2010)

$$\phi\left(b\right) = \phi_1\left(1 + \frac{b}{\phi_2}\right)^{1-\sigma} \quad (7)$$

- where ϕ_1 is the concern about leaving bequests, ϕ_2 measures the extent to which bequests are a luxury good.

Model

Endowments

- 3 skill types to match labor income quintiles

$$\rho \in \{low, low, medium, high\}$$

- Deterministic: Labor efficiency differs by skill type, and evolves over age

$$e_{\rho,j}: \text{ age-dependent labor effiency} \tag{8}$$

- Stochastic: shocks to labor efficiency within skill types

$$z_{\rho,j} = [low, medium, high]$$
$$\pi_j \left(z_{\rho,j+1} | z_{\rho,j}\right)$$

- Effective labor services

$$h_j = (1 - l_j)\, e_j z_j \tag{9}$$

Model

Fiscal policy

1. Progressive income tax system (parametric tax function)

$$T(y_j) = y_j - \lambda y_j^{1-\tau} \tag{10}$$

2. Constant consumption tax rate τ^c.
3. Means-tested pension
4. Public transfers to those below 65 years $st_{\rho,j}$: (exogenous, match public transfer shares by skill types and shocks)

Model

Means-tested pension

$$\mathscr{P}(a_j, y_j) = \begin{cases} \min\{\mathscr{P}^a(a_j), \mathscr{P}^y(y_j)\} & \text{if } j \geq j^P \\ 0 & \text{otherwise} \end{cases} \tag{11}$$

- Asset test

$$\mathscr{P}^a(a_j) = \begin{cases} p^{\max} & \text{if } a_j \leq \bar{a}_1 \\ p^{\max} - \omega_a(a_j - \bar{a}_1) & \text{if } \bar{a}_1 < a_j < \bar{a}_2 \\ 0 & \text{if } a_j \geq \bar{a}_2 \end{cases} \tag{12}$$

- Income test

$$\mathscr{P}^y(y) = \begin{cases} p^{\max} & \text{if } y_j \leq \bar{y}_1 \\ p^{\max} - \omega_y(y_j - \bar{y}_1) & \text{if } \bar{y}_1 < y_j < \bar{y}_2 \\ 0 & \text{if } y_j \geq \bar{y}_2 \end{cases} \tag{13}$$

Model

Government budget constraint

1. Balanced budget

$$\sum_j T(y_j)\mu(\chi_j) + \sum_j T(c_j)\mu(\chi_j) = \sum_j \mathscr{P}(\chi_j)\mu(\chi_j) + \sum_j st_j\mu(\chi_j) + G + rD \quad (14)$$

2. Written in terms of the scale of the income tax

$$\lambda = \frac{\sum_j y_j\mu(\chi_j) + \sum_j T(c_j)\mu(\chi_j) - Expenses}{\sum_j y_j^{(1-\tau)}\mu(\chi_j)} \quad (15)$$

Model

Firms and market structure

- Single representative firm

$$\max_{K,H} \{AF(K,H) - qK - wH\}$$

- One-period riskless asset: imperfectly self-insure against idiosyncratic earnings risk and mortality risks.
- Small open economy:
    - free flow of financial capital
    - domestic interest rate is equal to the world interest rate r such that rental price of capital is

$$q = r + \delta$$

Household's problem

- Let $\chi_j = (e_j, z_j, j)$ denote agent's state variables at age j.

$$V^j(\chi_j) = \max_{c_j, l_j, a_{j+1}} \left\{ u(c_j, l_j) + \beta \psi_j E\left[V^{j+1}(\chi_{j+1}) | e_j\right] + (1-\psi_j)\phi b(a_{j+1}) \right\} \quad (16)$$

subject to

$$a_{j+1} = a_j + e_j(1-l_j) w + r a_j + b_j + st_j + \mathscr{P}(a_j, y_j) - T(y_j) - (1+\tau^c) c_j \quad (17)$$

$$a_j \geq 0, 0 < l_j \leq 1 \quad (18)$$

Equilibrium

1. $\{c_j(\chi_j), l_j(\chi_j), a_{j+1}(\chi_j)\}_{j=1}^{J}$ solve the household problem;
2. The firm chooses labor and capital inputs to solve the profit maximization problem;
3. Total lump-sum bequest transfer is equal to the total amount of assets left by all deceased agents
   Current account is balanced and foreign assets A_f freely adjust so taht $r = r^w$, where r^w is the world interest rate;
4. Domestic market for capital and labor clear
5. The government budget constraint is satisfied

Functional forms and calibration

Summary

- Model is calibrated to match key features of the Australian economy 2000 - 2016.
- One model period equals 5 years. Agents enter model at age 20 and live a maximum up to 90 years. Eligible for pension at age 65.
- Survival probablities from Life Tables 2003-2016 (ABS)
- Annual growth rate $n = 1.56\%$, long run average population growth (ABS)
- Labor efficiency and transition probabilities derived from hourly wage data (HILDA 2001-2016).
- Firms Cobb-Douglas production function

$$Y = AK^{\alpha}H^{1-\alpha}$$

- Fiscal parameters calibrated to match fiscal targets and income distribution (see benchmark model performance).

Functional forms

Preferences

- Instantenous utility obtained from consumption and leisure

$$u(c_j, l_j) = \frac{\left[(1+d_j)^{\eta\gamma} c_j^{\gamma} l_j^{1-\gamma}\right]^{1-\sigma}}{1-\sigma} \tag{19}$$

γ - consumption weight, d_j - average depedent children by age, η is adjustment for children's consumption, σ - relative risk aversion.

- Utility from bequething

$$\phi(b) = \phi_1 \left(1 + \frac{b}{\phi_2}\right)^{1-\sigma} \tag{20}$$

ϕ_1 - concern over leaving bequests, ϕ_2- extent to which bequest is a luxury good.

Parameter values

Table: Key parameter values and calibration targets/source

Parameter	Value	Details
Preferences		
Discount factor	$\beta = 0.994$	Match S/Y
Inverse of intertemporal elasticity of substitution	$\sigma = 3$	
Share parameter for leisure	$\gamma = 0.245$	Match labor supply profile
Weight of children in utility	$\eta = 0.6$	Nishiyama and Smetters (2007)
Weight of bequest motive	$\phi_1 = -9.5$	De Nardi (2010)
Extent to which bequest is a luxury good	$\phi_2 = -11.5$	De Nardi (2010)
Technology		
Annual growth rate	$g = 0.033$	
Total factor productivity	$A = 1$	
Share parameter of capital	$\alpha = 0.4$	
Annual depreciation rate	$\delta = 0.055$	

Outline

Empirical fit of the parametric tax function

Table: ATO select years

	2008	2012	2016
τ	0.086	0.082	0.081
	(0.001)	(0.001)	(0.001)
λ	2.129	2.073	2.048
	(0.007)	(0.005)	(0.006)
Adjusted R^2	0.99	0.99	0.99

Comparison of benchmark with data 2000 - 2016

Table: Comparison of model generated values for key variables with Australian data

Variable	Model	Data
Household savings [a]	23.32	22.18
Income tax revenue [a]	16.86	10.47
Consumption tax revenue [a]	5.87	4.86
Total tax revenue [a]	22.73	24
Social welfare transfers [a]	4.74	4.95
Age pension [a]	2.18	2.42
Market income (labor and capital income) inequality [b]	0.57	0.57
Post-government (after tax and transfer) income inequality [b]	0.45	0.41
Income tax progressivity parameter τ^y	0.085	0.085
Average level of taxation λ	2.55	2.61
Suits index of income tax progressivity	0.2	0.2

[a] In % share of GDP. [b] Gini coefficient.

Outline

Alternative preferences

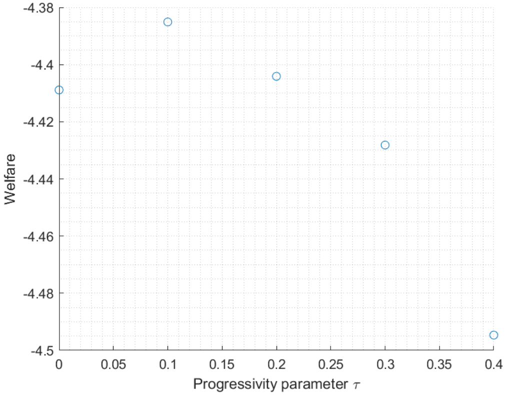
$$u(c,l) = \frac{\left[c^{\gamma} l^{1-\gamma}\right]^{1-\sigma}}{1-\sigma} \text{ or } u(c,l) = \frac{c^{1-\sigma}}{1-\sigma} - \chi \frac{(1-l)^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}$$

Table: Optimal progressivity and taper rate under alternative preferences

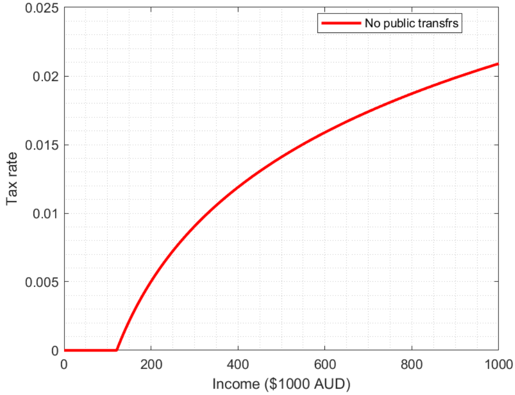
Labor supply elasticity	Optimal τ^y	Optimal ω^y	Average tax rate (%)
Varying over the lifecyle with $\sigma = 2$ (benchmark)	0	0.1	9.05
Varying over the lifecyle with $\sigma = 3$	0	0.2	15.41
Varying over the lifecyle with $\sigma = 4$	0	0.3	15.03
Constant Frisch elasticity	0	0.2	15.64

σ is risk aversion parameter; Frisch is $\frac{l}{1-l}\frac{1-\gamma(1-\sigma)}{\sigma}$

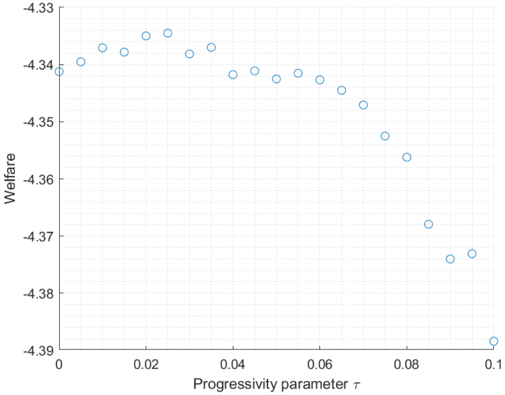
Switch off public transfers



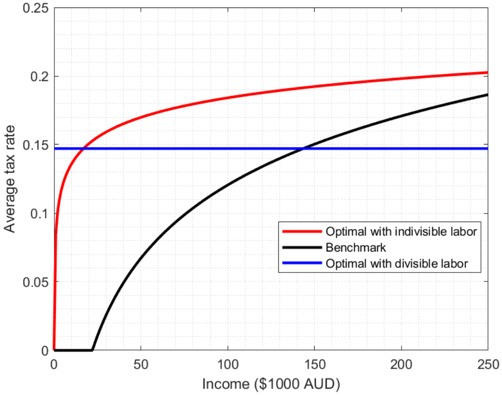
Switch off public transfers



Indivisible labor hours



Indivisible labor



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